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Also of interest to the following committees Intéresse également les comités suivants	Supersedes document Remplace le document 80/227/CDV - 80/250/RVC	

Horizontal functions concerned
Fonctions horizontales concernées

☐ Safety / Sécurité ☐ EMC / CEM ☐ Environment / Environnement ☐ Quality assurance / Assurance de la qualité

INTERNATIONAL ELECTROTECHNICAL COMMISSION — COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

Title

Maritime navigation and radiocommunication equipment and systems - Radar plotting aids - Part 3: Electronic plotting aid (EPA) - Performance requirements - Methods of testing and required test results

Titre

ATTENTION
VOTE PARALLÈLE
CEI – CENELEC

L'attention des Comités nationaux de la CEI, membres du CENELEC, est attirée sur le fait que ce projet final de Norme internationale est soumis au vote parallèle. Un bulletin de vote séparé pour le vote CENELEC leur sera envoyé par le Secrétariat Central du CENELEC.

ATTENTION
IEC – CENELEC
PARALLEL VOTING

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this final Draft International Standard (DIS) is submitted for parallel voting. A separate form for CENELEC voting will be sent to them by the CENELEC Central Secretariat.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR PLOTTING AIDS –

Part 3: Electronic plotting aid (EPA)– Performance requirements – Methods of testing and required test results

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
~~2)~~ 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
~~3)~~ 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60872-3 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/XXX/FDIS	80/XXX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A, B, C and D form an integral part of this standard.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR PLOTTING AIDS –

Part 3: Electronic plotting aid (EPA) -– Performance requirements – Methods of testing and required test results

1 Scope

This part of IEC 60872 specifies the minimum operational and performance requirements, methods of testing and test results for equipment that complies with performance standards not inferior to those adopted by the International Maritime Organization (IMO) in resolution MSC.64 (67) Annex 4 – Appendix 2. In addition, this standard takes account of IMO Resolution A.694 and is associated with IEC 60945.

When a requirement in this standard is different from IEC 60945, the requirement in this standard takes precedence.

The electronic plotting aid for manual direct plotting is intended for small ships fitted with either a gyrocompass or a transmitting marine electromagnetic compass conforming to ISO 11606 or a transmitting magnetic heading device conforming to IMO MSC.86(70) – annex 2, and a speed and distance measuring equipment (SDME) conforming to IMO Resolution A.824 and IEC 61023. This plotting aid is not suitable for ships classed as high-speed craft.

All texts in this standard, the wording of which is identical to that in IMO resolution MSC.64 (67) Annex 4 – Appendix 2, are printed in *italics* and the resolution and paragraph numbers are indicated in brackets.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60872. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60872 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60872-1:1998, *Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 1: Automatic radar plotting aid (ARPA) – Methods of testing and required test results*

IEC 60872-2: 1999, *Maritime navigation and radiocommunication equipment and systems – Radar plotting aids – Part 2: Automatic tracking aid (ATA) – Methods of testing and required test results*

IEC 60936-1:1999, *Maritime navigation and radiocommunication equipment and systems – Radar – Part 1: Shipborne radar – Performance requirements - Methods of testing and required test results*

IEC 60945:1996, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61023:1999, *Maritime navigation and radiocommunication equipment and systems – Marine speed and distance measuring equipment (SDME) – Performance requirements – Methods of testing and required test results*

IEC 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

ISO: 11606, *Ships and marine technology – Marine electromagnetic compasses*[1]

ISO 9000 (all parts), *Quality management and quality assurance standards*

IMO Resolution A.694:1991, *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids*

IMO Resolution A.823:1995, *Performance standards for automatic radar plotting aids (ARPAs)*

IMO Resolution A.824:1995, *Performance standards for devices to indicate speed and distance*

IMO MSC/Circular 603:1993, *Guidelines on display sizes and techniques for navigational purposes*

IMO MSC.64(67):1996, *Annex 4 – Performance standards for radar equipment, and Appendix 2 – Electronic plotting aids*

IMO MSC.86(70):1998, *Annex 2 – Performance standards for marine transmitting magnetic heading devices (TMHDs)*

IHO S-52: 1996, *Specifications for chart content and display aspects of ECDIS*

3 Performance requirements

3.1 Introduction

3.1.1 The electronic plotting aid (EPA) shall, in order to improve the standard of collision avoidance at sea:

.1 reduce the workload of observers by enabling them to obtain information about plotted targets so that they can perform as well with several separate targets as they can by manually plotting a single target;

.2 provide continuous, accurate and rapid situation evaluation.

3.1.2 The radar facilities provided by an EPA display shall comply with those clauses of IEC 60936-1 appropriate to its mode of use.

3.1.3 In addition to the general requirements contained in IEC 60945, the EPA shall comply with the following minimum requirements.

3.1.4 Additional ARPA or ATA facilities, not mandated in this EPA standard, may be provided. Such facilities shall comply with IEC 60872-1 and IEC 60872-2 as applicable.

3.1.5 Quality assurance

The EPA shall be designed, produced and documented by companies complying with ISO 9000, as applicable.

[1] To be published.

3.2 Definitions

Definitions of terms used in these performance standards are given in annex A.

3.3 (MSC.64 (67)/Annex 4/Appendix2/2) Performance standards

3.3.1 (App2/2.1) The electronic plotting aid (EPA) shall provide a means to plot a minimum of 10 targets on a radar display.

See annex D for a description of how manual plotting shall be implemented.

3.3.2 (App2/2.2) **Range scales**

3.3.2.1 *It* shall *be possible to plot targets on the 3, 6 and 12 nautical mile range scales. The facility may be provided on additional range scales.* There shall be a positive indication of the range scale in use*. Plots* shall *be maintained when switching between range scales.* The methods of operation that are provided shall be clearly described in the manufacturer's manual*.*

3.3.2.2 After changing range scales on which the EPA facilities are available or on resetting the display, full plotting information shall be displayed within a period of time not exceeding one scan of 360°.

3.3.3 (App2/2.3) *It* shall *be possible to plot targets with a relative speed up to 75 knots.*

3.3.4 (App2/2.4) *It* shall *be possible for the operator to adjust the CPA*/*TCPA limits and the vector time.*

3.3.5 Plot positions and identification

3.3.5.1 (App2/2.5) *Plot positions* shall *be identified by an approved symbol* (see annex C symbols 1, 4 or 6) *and an associated plot number. It* shall *be possible to switch off the plot number.*

3.3.5.2 Automatically applied 'target identities' shall not be re-used until, as a minimum, the number assigned equals the maximum number of plotted targets.

3.3.6 (App2/2.6) *The minimum lapsed time between any two plots* shall *be greater than 30 s.*

3.3.7 (App2/2.7) A*fter the second plot, a vector* shall *be displayed on the target. It* shall *be possible to select a true or relative vector. There* shall *be a positive indication of vector mode*, including an indication of sea or ground stabilization.

.1 vectors displayed shall be time-adjustable;

.2 a positive indication of the time-scale of the vector in use shall be given.

3.3.8 (App2/2.8) *The vector origin* shall *move across the screen at a rate and direction defined by the calculated true course and speed.*

3.3.9 (App2/2.9) *It* shall *be possible to correct the position of a plot.*

3.3.10 (App2/2.10*) It* shall *be possible, on demand, to display the following data on a selected target:*

.1 plot number: time since last plot (min);

.2 present range of the target;

.3 present true bearing of the target;

.4 predicted target range at the closest point of approach (CPA);

.5 predicted time to CPA (TCPA);

NOTE If the CPA has passed, it shall be indicated by a TCPA with a negative (–) sign.

.6 calculated true course of target;

.7 calculated true speed of target.

The selected plot shall *be clearly identified with an approved symbol* (see annex C, symbol 12) *and the plot data* shall *be displayed outside of the screen radar area.* If data is required for more than one target at the same time each symbol shall be separately identified, for example with a number adjacent to the symbol.

3.3.11 (App2/2.11)*There* shall *be an indication* by a text message including the plot number *of any plot that is not updated for 10 min. The plot* shall *be dropped if the time between consecutive plots exceeds 15 min.*

3.3.12 Display

3.3.12.1 The display may be a separate or integral part of the ship's radar. However the EPA display shall include all the data required to be provided by a radar display in accordance with the performance standards for navigational radar equipment.

3.3.12.2 The design shall be such that any malfunction of EPA parts producing data additional to information to be produced by the radar, as required by the performance standards for navigational equipment, shall not affect the integrity of the basic radar presentation.

The equipment shall be regarded as complying with the above requirement if the design is such that, where practicable, correct operation of the radar system in accordance with IEC 60936-1 will not be affected by malfunction of any EPA sub-system that is not an essential part of the radar.

3.3.12.3 The EPA shall be capable of operating with a relative or true motion display with "north-up" azimuth stabilization. There shall be a positive indication of the display mode and orientation in use.

3.3.12.4 The EPA information shall not obscure the visibility of radar targets. The display of EPA data (vector and associated symbol) shall be under the control of the radar observer. It shall be possible to cancel the display of unwanted EPA data within 3 s of command.

3.3.12.5 Means shall be provided to adjust independently the brilliance of the EPA data and radar data, including complete extinction of the EPA data.

3.3.12.6 The method of presentation shall ensure that the EPA data is clearly visible in general to more than one observer in the conditions of light normally experienced on the bridge of a ship by day and by night. Screening may be provided to shade the display from sunlight but not to the extent that it will impair the observer's ability to maintain a proper lookout. Facilities to adjust the brightness shall be provided (see IMO MSC/Circular 603).

3.3.13 Operational alarms and indications

3.3.13.1 The EPA shall have the capability to alarm the observer with a visual and audible signal of any tracked target that is predicted to close within a minimum range and time chosen by the observer. The target causing the alarm shall be clearly indicated with the relevant symbols (see annex C, symbol 8) on the display.

3.3.13.2 It shall be possible for the observer to activate or de-activate the audible alarm capability.

3.3.14 Connections with other equipment

3.3.14.1 The connection of the EPA to any other equipment shall not degrade the performance of that equipment. This requirement shall be met whether the EPA is operating or not. Additionally, the EPA shall be designed to comply with this requirement under fault conditions as far as is practicable.

3.3.14.2 Serial interfaces provided, shall comply with the IEC 61162 series, as applicable.

4 Methods of testing and required test results

4.1 General

Before these tests are effected, the equipment under test (EUT) shall be subjected to and satisfy the relevant parts of IEC 60945.

4.2 (3.3.1 to 3.3.11) Description of manual plotting tests

4.2.1 General principle

The manual plotting tests are intended to compare target data (CPA, TCPA, speed and course) gained simultaneously from the EUT of the EPA device and from evaluation of plot positions (range and bearing) while plotting a cursor position simulating a target position.

4.2.2 Operational conditions

The tests shall be carried out by entering plots to pre-defined positions (range and bearing) and own ship data according to test scenarios covering the most relevant sources of potential error. The test scenarios to be used are given in table 1 and are detailed in annex B. Faults of sensors and precision of positioning the cursor over a real radar target have no effects on these tests. Only the accuracy of the EPA calculations are tested.

Table 1 – Test scenarios

Scenario	Description
1	Target with nearly the same course and a risk of collision (CPA = 0); after 9 min change of own course 45° starboard (CPA > 0)
2	Own ship at anchor (SPD = 0); target approaches from 135° exactly towards own position (CPA = 0); own ship gets underway at +9 min and speed increases to 5 kt
3	Target with exactly the same course and speed; after 6 min reduction of own speed to 5 kt; after 12 min change of target course so that CPA = 0
4	Target with exactly opposite course; after 9 min change of own course 10° starboard to CPA > 0
5	Target with crossing course and a risk of collision (CPA = 0); after 6 min a reduction of own speed, target reduces accordingly (CPA = 0); after 12 min own course is changed 90° to port so that CPA > 0
6	Target with opposite course manoeuvres to a collision course (CPA = 0); after 12 min, own speed and course are changed; target changes its course accordingly (CPA = 0)

4.2.3 Method of measurement

With the gain reduced to a minimum, or off, own ship course and speed shall be set to the required values by using manual settings at the display.

Placing the cursor to the range and bearing values given by the scenario shall set plot marks.

The test scenarios shall be performed in plot intervals of 3 min. Target data including CPA, TCPA, course and speed obtained by the EUT and the range and bearing values entered into the EUT shall be read out and recorded.

Required own ship changes are performed at the beginning of the plot interval, immediately after the last plot has been set.

4.2.4 Results required

All data sets shall be evaluated by using these valid values for range and bearing, compared with the target data obtained by the EUT (thus target data are not compared with the original scenario data; the scenario is only a means of making the tests comparable). Acceptable tolerances for evaluation of scenarios shall be:

a) CPA: ±0,1 nm for CPA < 1 nm and range < 6 nm. In other cases, ±5 % of the range scale in use.

b) TCPA: ±2 min for TCPA < 10 min and range < 6 nm. In other cases, ±20 % of the calculated TCPA.

c) Course: ±5°.

d) Speed: ± 1 kt.

4.3 (3.1.5) Quality assurance

Check by practical demonstration and inspection of the relevant documentation.

4.4 (3.3.12) Display

Check by inspection of the EUT.

4.5 (3.3.13) Audible alarms

Check by inspection of the EUT.

4.6 (3.3.14) Connections with other equipment

Check by practical demonstration and inspection of the documentation.

Annex A
(normative)

Definitions of terms to be used in connection with electronic plotting aids (EPAs) and radar performance standards

(Annex 1 to appendix 1 of IMO Resolution MSC.64(67) Annex 4)

Azimuth stabilized display:	*A display in which the azimuth orientation relative to a nominated true bearing is fixed*
CPA/TCPA:	*Closest point of approach and time to closest point of approach limit as defined by the observer to give warning when a tracked target or targets will close to within these limits from own ship*
Ground stabilization:	*A mode of display whereby own ship and all targets are referenced to the ground using ground track or set and drift inputs*
Heading:	*The direction in which the bows of a ship are pointing expressed as an angular displacement from north*
North-up display:	*An azimuth stabilized display in which a line connecting the centre of own ship with the top of the display is north true bearing*
Relative bearing:	*The direction of a target from own ship expressed as an angular displacement from own ship's heading*
Relative course:	*The direction of motion of a target relative to own ship's position expressed as an angular displacement from north. It is deduced from a number of measurements of target range and bearing on own ship's radar*
Relative motion:	*The combination of relative course and relative speed*
Relative motion display:	*A display on which the position of own ship remains fixed and all targets move relative to own ship*
Relative speed:	*The speed of a target relative to own ship's position. It is deduced from a number of measurements of target range and bearing on own ship's radar*
Relative vector:	*The predicted movement of a target relative to own ship*
Sea stabilization:	*A mode of display whereby own ship and all targets are referenced to the sea, using gyro heading and single axis log water speed inputs*
Target:	*Any object fixed or moving whose position and motion is determined by measurements of range and bearing on radar*
Target's predicted motion:	*A prediction of future target motion based on linear extrapolation from its present motion as determined by past measurements of its range and bearing on the radar*

Trails:	*Tracks displayed by the radar echoes of targets in the form of a synthetic afterglow. The trails may be either relative or true. The true trails may be sea or ground stabilized*
True bearing:	*The direction of a target from own ship or from another target expressed as an angular displacement from north*
True course:	*The true direction of motion of a target expressed as an angular displacement from north. It is obtained by a vector combination of target relative motion and own ship's true motion*
True motion:	*The combination of true course and true speed*
True motion display:	*A display across which own ship and each target moves with its own true motion*
True speed:	*The speed of a target obtained by a vector combination of target relative motion and own ship's true motion **
True vector:	*The predicted true motion of a target as a result of own ship's direction and speed input. The true vector may be either displayed with reference to the water or to the ground*

** For the purposes of these definitions there is no need to distinguish between sea and ground stabilization.*

NOTE Where reference is made to target range, bearing, relative course or relative speed, closest point of approach (CPA) or time to closest point of approach (TCPA), these measurements are made with respect to the radar antenna.

Annex B
(normative)

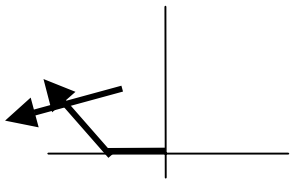
Operational scenarios

NOTE In all scenarios the following abbreviations are used:

T:	true;	CPA:	closest point of approach;
R:	relative;	TCPA:	time to closest point of approach;
nm:	nautical miles;	CSE:	course;
kt:	knots;	RNG:	range;
SPD:	speed;	BRG:	bearing;
HDG:	heading.		

In all scenarios the ⟶ of own ship changes, indicate an instantaneous change of SPD or CSE after plotting. The diagrams in the scenarios represent the true resultant path.

Scenario 1

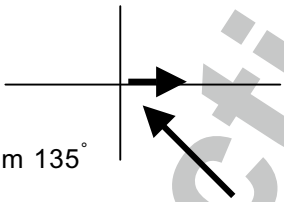


Target with nearly the same course and risk of collision (CPA = 0);

after 9 min, change of own course 45° starboard (CPA > 0).

Plot No.	Time min	Own ship		Cursor		Target data					
		SPD kt	CSE °	RNG nm	T BRG °	R SPD kt	R CSE °	T SPD kt	T CSE °	CPA nm	TCPA min
1	0,00	25	270	5,00	315,00						
2	3,00	25	270	4,85	315,00	3,0	135,0	23,0	264,7	0,0	97,0
3	6,00	25	270	4,70	315,00	3,0	135,0	23,0	264,7	0,0	94,0
4	9,00	25	270→ 315	4,55	315,00	3.0	135,0	23,0	264,7	0,0	91,0
5	12,00	25	315	4,13	302,64	20,5	194,7	23,0	264,7	3,9	3,7
6	15,00	25	315	3,94	288,32	20,5	194,7	23,0	264,7	3,9	0,7
7	18,00	25	315	4,01	273,54	20,5	194,7	23,0	264,7	3,9	–2,3
8	21,00	25	315	4,32	260,11	20,5	194,7	23,0	264,7	3,9	–5,3

Scenario 2

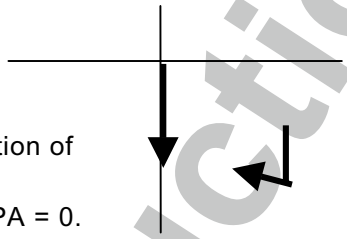


Own ship at anchor (SPD = 0) at time t_0; target approaches from 135° exactly towards own position (CPA = 0); after 9 min, own ship gets underway at t_0 + 10 min and speed increases to 5 kt.

For plots 1 to 4 – CSE 0º indicates HDG 0º

Plot No.	Time min	Own ship		Cursor		Target data					
		SPD kt	CSE °	RNG nm	T BRG °	R SPD kt	R CSE °	T SPD kt	T CSE °	CPA nm	TCPA min
1	0,00	0	0	5,00	135,00						
2	3,00	0	0	4,50	135,00	10,0	315,0	10,0	315,0	0,0	27,0
3	6,00	0	0	4,00	135,00	10,0	315,0	10,0	315,0	0,0	24,0
4	9,00	0→ 5	0→ 90	3,50	135,00	10,0	315,0	10,0	315,0	0,0	21,0
5	12,00	5	90	2,83	138,58	14,0	300,4	10,0	315,0	0,9	11,5
6	15,00	5	90	2,18	144,35	14,0	300,4	10,0	315,0	0,9	8,5
7	18,00	5	90	1,56	154,84	14,0	300,4	10,0	315,0	0,9	5,5
8	21,00	5	90	1,06	176,73	14,0	300,4	10,0	315,0	0,9	2,5

Scenario 3

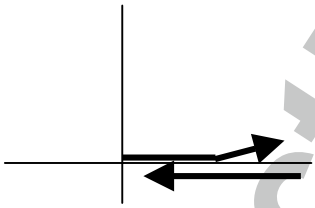


Target with exactly the same course and speed; after 6 min reduction of own speed to 5 kt; after 12 min change of target course so that CPA = 0.

Plot No.	Time min	Own ship		Cursor		Target data					
		SPD kt	CSE °	RNG nm	T BRG °	R SPD kt	R CSE °	T SPD kt	T CSE °	CPA nm	TCPA min
1	0,00	10	180	3,00	135,00						
2	3,00	10	180	3,00	135,00	0,0	0,0	10,0	180,0	2,1	**
3	6,00	10→5	180	3,00	135,00	0,0	0,0	10,0	180,0	2,1	**
4	9,00	5	180	3,18	138,19	5,0	180,0	10,0	180,0	2,1	–28,5
5	12,00	5	180	3,37	141,02	5,0	180,0	10,0	180,0	2,1	–31,5
6	15,00	5	180	2,70	141,02	13,4	321,0	10,0	302,7	0,0	12,1
7	18,00	5	180	2,03	141,02	13,4	321,0	10,0	302,7	0,0	9,1
8	21,00	5	180	1,37	141,02	13,4	321,0	10,0	302,7	0,0	6,1

** TCPA > 99 or undefined.

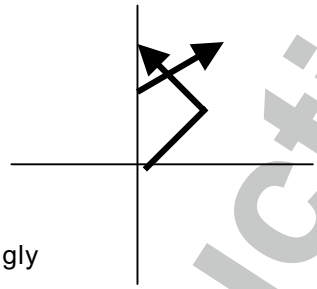
Scenario 4



Target with exactly opposite course; after 9 min change of own course 10° starboard to CPA > 0.

Plot No.	Time min	Own ship		Cursor		Target data					
		SPD kt	CSE °	RNG nm	T BRG °	R SPD kt	R CSE °	T SPD kt	T CSE °	CPA nm	TCPA min
1	0,00	10	90	5,00	90,00						
2	3,00	10	90	4,00	90,00	20,0	270,0	10,0	270,0	0,0	12,0
3	6,00	10	90	3,00	90,00	20,0	270,0	10,0	270,0	0,0	9,0
4	9,00	10	90→ 100	2,00	90,00	20,0	270,0	10,0	270,0	0,0	6,0
5	12,00	10	100	1,01	85,08	19,9	275,0	10,0	270,0	0,2	3,0
6	15,00	10	100	0,17	5,00	19,9	275,0	10,0	270,0	0,2	0,0
7	18,00	10	100	1,01	284,92	19,9	275,0	10,0	270,0	0,2	–3,0
8	21,00	10	100	2,00	280,00	19,9	275,0	10,0	270,0	0,2	–6,0

Scenario 5



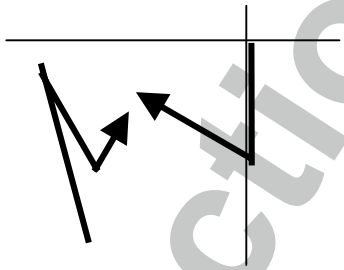
Target with crossing course and a risk of collision (CPA = 0);

after 6 min a reduction of own speed, target reduces accordingly

(CPA = 0); after 12 min own course is changed 90° to port so that CPA > 0.

Plot No.	Time min	Own ship		Cursor		Target data					
		SPD kt	CSE °	RNG nm	T BRG °	R SPD kt	R CSE °	T SPD kt	T CSE °	CPA nm	TCPA min
1	0,00	25	45	5,00	30,00						
2	3,00	25	45	4,50	30,00	10,0	210,0	15.6	54,6	0,0	27,0
3	6,00	25→15	45	4,00	30,00	10,0	210,0	15.6	54,6	0,0	24,0
4	9,00	15	45	3,75	30,00	5,0	210,0	10,3	52,3	0,0	45,0
5	12,00	15	45→315	3,50	30,00	5,0	210,0	10,3	52,3	0,0	42,0
6	15,00	15	315	3,89	43,66	19,2	103,0	10,2	52.2	3,3	–6,2
7	18,00	15	315	4.46	54,34	19,2	103,0	10,2	52,3	3,3	–9,2
8	21,00	15	315	5,14	62,41	19,2	103,0	10,3	52.3	3,3	–12,2

Scenario 6



Target with opposite course manoeuvres to a collision course (CPA = 0); after 12 min own speed and course is changed; target changes its course accordingly (CPA = 0).

Plot No.	Time min	Own ship		Cursor		Target data					
		SPD kt	CSE °	RNG nm	T BRG °	R SPD kt	R CSE °	T SPD kt	T CSE °	CPA nm	TCPA min
1	0,00	25	180	5,50	213,00						
2	3,00	25	180	4,00	229,00	27,4	359,6	14,8	358,2	3,0	3,9
3	6,00	25	180	3,50	229,00	10,0	49,0	19,9	157,7	0,0	21,0
4	9,00	25	180→ 200	3,00	229,00	10,0	49,0	19,9	157,7	0,0	18,0
5	12,00	25	200	2,75	229,00	5,0	49,0	20,8	193,3	0,0	33,0
6	15,00	25→5	200	2,50	229,00	5,0	49,0	20,8	193,3	0,0	30,0
7	18,00	5	290	3,33	214,64	21,9	180,2	20,8	193,3	1,9	–7,5
8	21,00	5	290	4,28	206,31	21,9	180,2	20,8	193,3	1,9	–10,5

Annex C
(normative)

Electronic plotting video symbols (EPVS)

C.1 General

C.1.1 IMO Resolution MSC.64(67) annex 4 for marine radar, requires that certain indications and alarms are given on electronic plotting aids for anti-collision purposes.

Video symbols 1, 4, 6, 8 and 12, illustrated in this annex, shall be used on EPA.

C.1.2 The size of the video symbols in the text assumes a 340 mm effective diameter display. Where the size of alpha-numerics are not specified, they shall be not less than 6 mm high. For smaller diameter displays the size may be proportionally smaller.

C.1.3 Other symbols may be used for other anti-collision functions provided they do not conflict with EPVS of IEC 60872-1, navigational symbols for radar (annex E of IEC 60936-1) and IHO chart symbols (IHO S-52). The use of these other anti-collision symbols shall be limited to ensure that they do not obscure the anti-collision requirements of the electronic plotting aids.

C.1.4 If two or more symbols simultaneously apply to a target, then the symbols may be displayed together, provided that they are clearly distinguishable.

C.1.5 The CPA/TCPA alarm (symbol 8) is to be used for any plotted target which is predicted to close within a minimum range and time chosen by the observer.

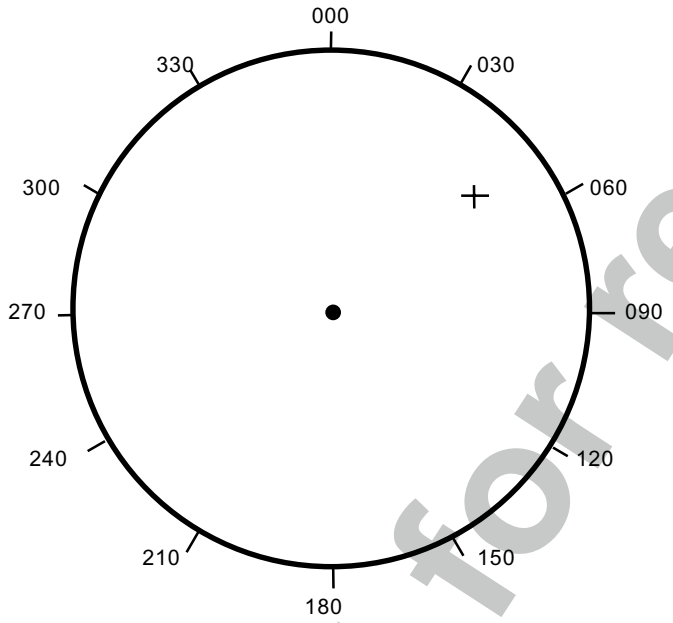
C.1.6 Additional ARPA or ATA facilities, not mandated in this EPA symbol annex, may be provided. Such facilities shall comply with annex E of IEC 60872-1 or IEC 60872-2 as applicable.

C.2 Symbols

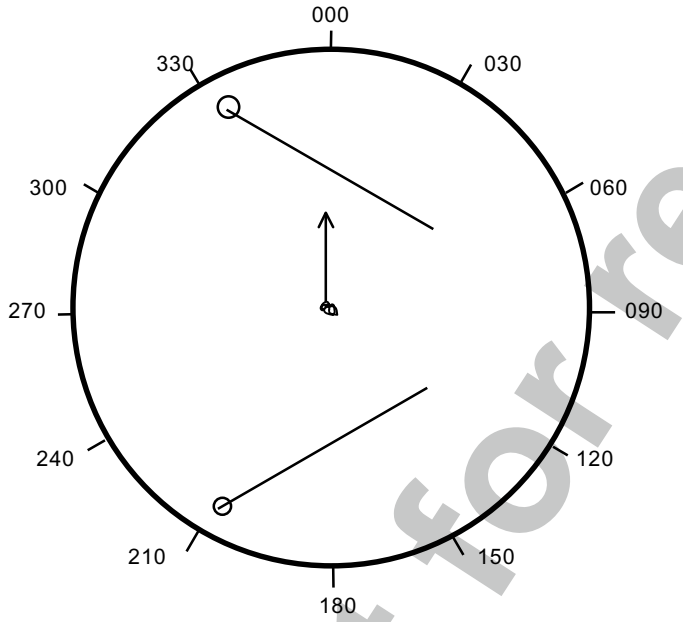
The following symbols are graphically presented within a representation of a radar plotting display, which includes a bearing scale graduated at nominal 30° intervals. In practice the bearing scale is divided into marks at least every 5° (see IEC 60936-1).

The diagrams that follow are intended to illustrate only the form of the symbols.

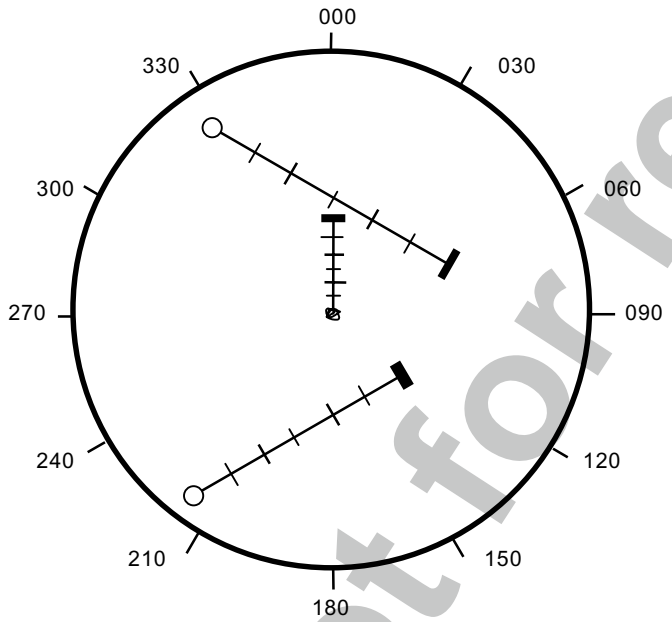
C.2.1 Symbol 1

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.2.1 of IMO A.823 3.3.2.1 of IEC 60872-1 3.3.2.1 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**1** ARPA ATA EPA	Manual acquisition and plotting	A cross shall be used as the cursor for manual acquisition on an ARPA and ATA and for plotting on an EPA
			NOTE 1 The cross shall be at least 10 mm in height and 10 mm in width to avoid confusion with other navigational and chart symbols, as well as for electronic chart display and information system (ECDIS) harmonization. NOTE 2 The cursor is also used for other radar purposes.

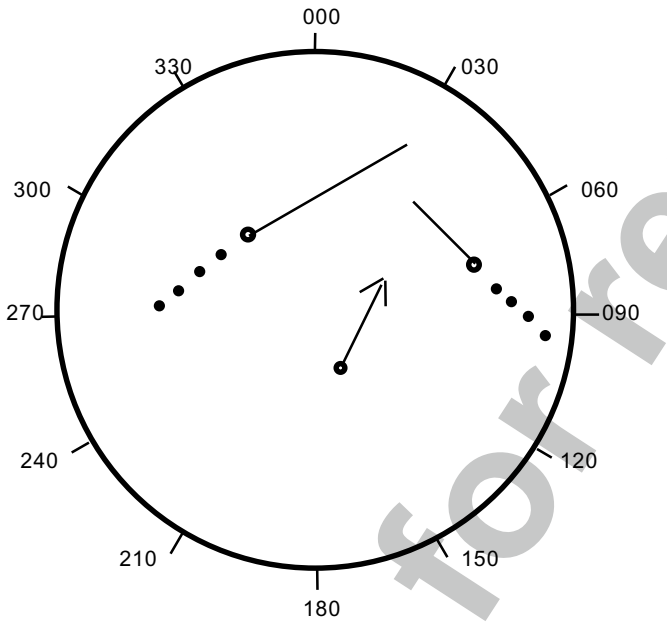
C.2.2 Symbol 4A

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823 3.3.4.6 of IEC 60872-1 3.3.4.6 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**4A** ARPA ATA EPA	Course and speed vector. Target being tracked when tracking is in steady state. *The course and speed information generated by the ARPA*/ATA/EPA *for targets* shall *be displayed in vector or graphic form*	A vector indicating the target's predicted true or relative motion which may have a fixed time scale or time-adjusted scale. The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter. The position of own ship shall always be indicated by a dot
			NOTE Optionally an open arrow or a double arrow may be added, if chosen by the user, to the end of own ship true vector. This is to indicate that all the vectors are sea stabilized to show course and speed through water (single arrow) or ground stabilized to show course and speed over the ground (double arrow) respectively.

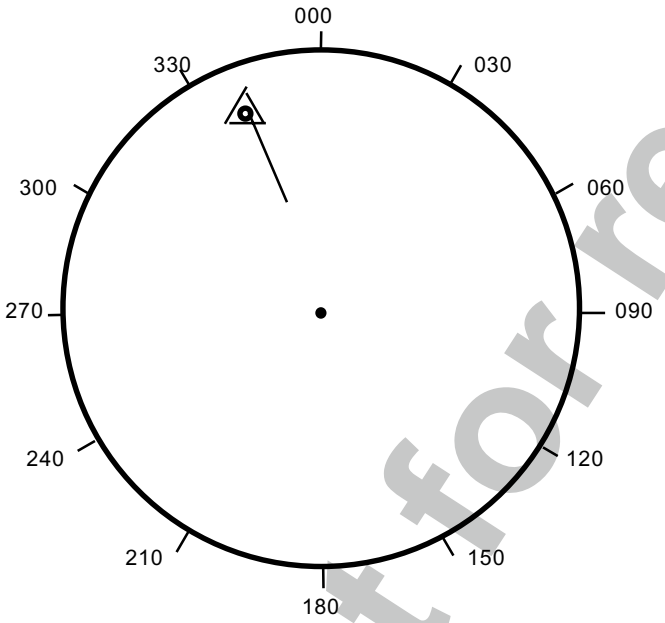
C.2.3 Symbol 4B

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.4.6 of IMO A.823 3.3.4.6 of IEC 60872-1 3.3.4.6 of IEC 60872-2 3.3.5.1 of IEC 60872-3	**4B** ARPA ATA EPA	Course and speed vector. Target being tracked when tracking is in steady state. *The course and speed information generated by the ARPA*/ATA/EPA *for targets* shall *be displayed in vector or graphic form*	As for vector indicating the target's predicted true or relative motion, which may have a fixed time scale or time-adjusted scale. The vector origin is to be defined by a small dot or the centre of a circle. The circle shall be at least 2 mm in diameter
			NOTE 1 Optionally an open arrow or a double arrow may be added, if chosen by the user, to the end of own ship true vector. This is to indicate that all vectors are sea stabilized to show course and speed through the water (single arrow) or ground stabilized to show course and speed over the ground (double arrow) respectively. NOTE 2 Marks at 1 min intervals. Bold mark at 6 min intervals. Length represents user-selectable period applied to ALL vectors

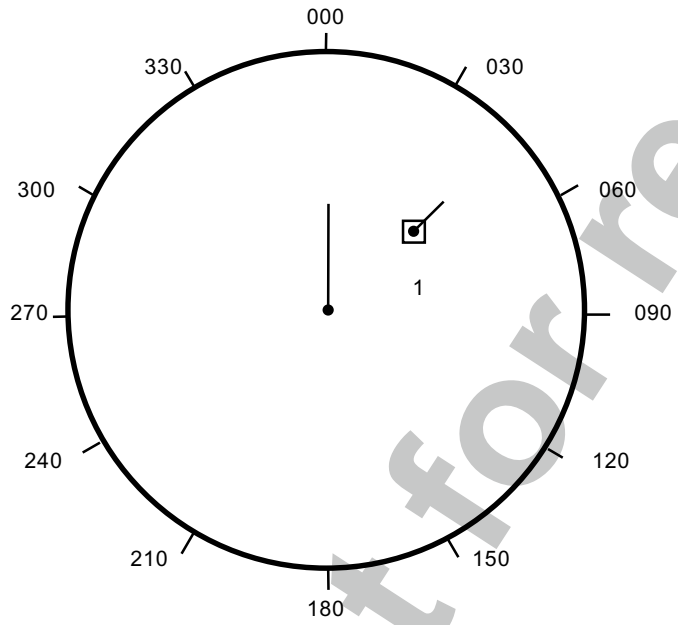
C.2.4 Symbol 6

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.3.5 of IMO A.823 3.3.3.8 of IEC 60872-1 3.3.5.1 of IEC 60872-3	**6** ARPA EPA	Past position of target on ARPA. *The ARPA* shall *be able to display on request at least four equally time-spaced past positions of any targets being tracked over a period appropriate to the range scale in use.* Plot position of targets on EPA	At least four equally time-spaced past positions to be shown on request as dots on an ARPA. An associated plot number adjacent to the initial plot and subsequently adjacent to the vector origin shall identify plot positions. On EPA, the past plot positions may not be equally time-spaced and are not shown astern of own ship
			This diagram applies to EPA only. For ARPA see IEC 60872-1

C.2.5 Symbol 8

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.5.2 of IMO A.823 3.3.5.6 of IEC 60872-1 3.3.5.6 of IEC 60872-2 3.3.13.1 of IEC 60872-3	**8** ARPA ATA EPA	CPA /TCPA alarm. *The ARPA*/*ATA*/EPA shall *have the capability to alarm the observer with a visual and audible signal of any tracked target which is predicted to close within a minimum range and time chosen by the observer. The target causing the alarm* shall *be clearly indicated on the display*	A flashing equilateral triangle, apex top, shall be used to mark the target. In addition, the target vector may be flashed
			NOTE 1 Flashing is at a frequency of about 0,5 Hz to 4 Hz. NOTE 2 After acknowledgement it is permissible to cease flashing.

C.2.6 Symbol 12

IMO/IEC references	EPVS symbol number	Detail	Description of symbol
3.6.1 of IMO A.823 3.3.6.1 of IEC 60872-1 3.3.6.1 of IEC 60872-2 3.3.10 of IEC 60872-3	**12** ARPA ATA EPA	Data requirements *Targets selected* shall *be marked with the relevant symbol on the radar display. If data is required for more than one target at the same time each symbol* shall *be separately identified, for example with a number adjacent to the symbol.*	A square is to be used as a symbol to mark the data reading target
			

Annex D
(normative)

Implementation of manual plotting

D.1 The operator positions a first plot over the centre of the target video at position p_1 and time t_1. After an appropriate period of time a second plot (plot 2) is positioned over the current centre of the target video at position p_2 and time t_2. These positions are stored on a conceptual grid that models the earth's surface or the surface of the water, depending on the method of stabilization being used (ground or water). After the second plot has been added the target's velocity is calculated using:

$$v_1 = (p_2 – p_1) / (t_2 – t_1)$$

A vector is then drawn at the position of the second plot with its length related to the velocity of the target. The vector is then drawn at the position of the second plot with its length related to the velocity of the target. The vector is periodically updated in the video circle using the assumption that the target has constant velocity. It can show the target's true or relative motion and the operator can alter its length (in minutes).

D.2 Over a period of time, discrepancies between the position of the target video and the origin of the vector can build up. These can be as a result of errors in the original plot positions, or as result of a change in velocity of the target. If the operator considers that the discrepancy is significantly large a new plot (plot 3) can be made on the current centre of the video. The velocity is then recalculated using the last two plots made:

$$v_2 = (p_3 – p_2) / (t_3 – t_2)$$

The vector origin is reset to the position of the latest plot (plot 3) and the target's velocity is set to v_2.

D.3 With reference to figure D.1 below, it can be seen that after the third plot the target's position and velocity are set to the best available estimates. Additionally, the operation is intuitive to the operator as small positional errors between the position of the target video and the vector origin are translated to small changes in position and velocity of the target after a corrective plot is added. Larger positional errors translate to larger changes in the position and velocity of the target. The target vector will then continue to be updated without the addition of a fourth plot until the errors grow again.

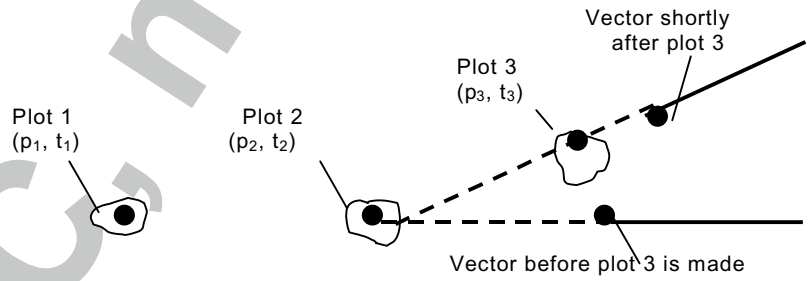


Figure D.1 – Diagram of three plots

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